IB CHEMISTRY TEST HL TOPIC 1 Term 2 2006

Section A

1. (M02) A compound that contains only carbon, hydrogen and oxygen has the following percentage by mass:

   carbon: 60% hydrogen: 8% oxygen: 32%

   What is a possible molecular formula?

   A. $C_5H_8O_2$. B. C_5H_4O C. C_6HO_3 D. C_7HO_4

2. (M02) Which sample contains the smallest amount of oxygen?

   A. 0.3 mol H_2SO_4 B. 0.6 mol O_3 C. 0.7 mol HCOOH D. 0.8 mol H_2O

3. (M02) 6.4 g of copper wire is added to 0.10 dm^3 of 1.0 mol dm^{-3} aqueous $AgNO_3$ to form metallic silver and aqueous copper (II) nitrate. When the reaction is complete,

   A. excess copper wire remains.
   B. all the copper wire dissolves and some silver ions are left in solution.
   C. All the copper wire dissolves and no silver ions are left in solution.
   D. The mass of metallic silver formed is equal to the mass of copper wire that reacts.

4. (M02) 2.02 g of KNO_3 (M_r= 101) is dissolved in sufficient water to prepare 0.500 dm^3 of solution. What is the concentration of this solution in mol dm^{-3}?

   A. 0.02 B. 0.04 C. 0.10 D. 0.20

5. (M03) What amount of oxygen, O_2, (in moles) contains 1.8×10^{22} molecules?

   A. 0.0030 B. 0.030 C. 0.30 D. 3.0

6. (M03) 3.0 dm^3 of sulfur dioxide are reacted with 2.0 dm^3 of oxygen according to the equation:

   $$2SO_2\,(g) + O_2\,(g) \longrightarrow 2SO_3\,(g)$$

   What volume of sulfur trioxide (in dm^3) is formed? (Assume the reaction goes to completion and all gases are measured at the same temperature and pressure.

   A. 5.0 B. 4.0 C. 3.0 D. 2.0

7. (M03) What volume (in dm^3) of 0.30 mol dm^{-3} NaCl solution can be prepared from 0.060 mol of solute?

   A. 0.018 B. 0.20 C. 0.50 D. 5.0

8. (N03) Which solution contains the smallest amount of H^+ ions?

A. 10.0 cm^3 of 0.250 mol dm^{-3} HCl
B. 20.0 cm^3 of 0.250 mol dm^{-3} HCl
C. 10.0 cm^3 of 0.500 mol dm^{-3} HCl
D. 10.0 cm^3 of 0.250 mol dm^{-3} H_2SO_4

9. (N03) A hydrocarbon contains 90% by mass of carbon. What is its empirical formula?

A. CH_2 B. C_3H_4 C. C_7H_{10} D. C_9H_{10}

10. (N03) Lithium hydroxide reacts with carbon dioxide as follows

$$2LiOH + CO_2 \longrightarrow Li_2CO_3 + H_2O$$

What mass (in grams) of lithium hydroxide is needed to react with 11g of carbon dioxide?

A. 6 B. 12 C. 24 D. 48

11. (M04) How many hydrogen atoms are contained in one mole of ethanol, C_2H_5OH?

A. 5 B. 6 C. 1.0×10^{23} D. 3.6×10^{24}

12. (M04) The percentage by mass of the elements in a compound is

C = 72% H = 12% O = 16%

What is the mole ratio C : H in the empirical formula of its compound?

A. 1 : 1 B. 1 : 2 C. 1 : 6 D. 6 : 1

13. (M04) What is the coefficient for O_2 (g) when the equation below is balanced?

$$\_\ C_3H_8\ (g) + \_\ O_2\ (g) \longrightarrow \_\ CO_2\ (g) + \_\ H_2O\ (g)$$

A. 2 B. 3 C. 5 D. 7

14. According to the equation

$$2SO_2\ (g) + O_2\ (g) \longrightarrow 2SO_3\ (g)$$

what volume of air (20% O_2) is required to react with 10 dm^3 of SO_2?

A. 2 dm^3 B. 5 dm^3 C. 10 dm^3 D. 25 dm^3

15. Which of the following compounds has the greatest **empirical** formula mass?

A. C_6H_6 B. C_4H_{10} C. C_3H_6 D. C_2H_6

16. $CaCO_3$ (s) $\longrightarrow$ CaO(s) + CO_2 (g)

When heated, $CaCO_3$ (M_r = 100) decomposes as shown above.
When 20 g of impure $CaCO_3$ is heated, 0.15 moles of CO_2 are obtained. What is the % purity of the $CaCO_3$?

A. 15 B. 25 C. 55 D. 75

Section B

1. (M02) A student is asked to prepare some copper (II) nitrate by reacting nitric acid with copper (II) oxide.

   (a) Write a balanced equation for this reaction. [1]

   (b) The student carries out this reaction by adding 0.0345 mol of copper (II) oxide to 36.0 cm^3 of 1.15 mol dm^{-3} nitric acid solution. Calculate the amount (in mol) of nitric acid. [1]

   (c) Use the information in (a) and (b) to identify the limiting reagent and determine the amount (in mol) of copper (II) nitrate formed. [2]

   (d) The product of this reaction is isolated as copper (II) nitrate trihydrate. Calculate the molar mass of copper (II) nitrate trihydrate and the mass of product obtained. [2]

2. (N02) An element X reacts with oxygen to form the oxide X_2O_3.

   (a) Write a balanced equation for the reaction. [1]

   (b) If 2.199g of the oxide was obtained from 1.239 of X, calculate the relative atomic mass of X and identify the element. [5]

   (c) Nitrogen also forms an oxide on reaction with oxygen. This oxide contains 25.9 % of nitrogen and 74.1 % of oxygen by mass. Calculate the empirical formula of this second oxide. [3]

3. (N03)
   (a) Aqueous XO_4^{3-} ions form a precipitate with aqueous silver ions, Ag^+. Write a balanced equation for the reaction, including state symbols. [2]

   (b) When 41.18 cm^3 of a solution of aqueous silver ions with a concentration of 0.2040 mol dm^{-3} is added to a solution of XO_4^{3-} ions, 1.172 g of the precipitate is formed.

      (i) Calculate the amount (in moles) of Ag^+ ions used in the reaction. [1]

      (ii) Calculate the amount (in moles) of the precipitate formed. [1]

      (iii) Calculate the molar mass of the precipitate. [2]

      (iv) Determine the relative atomic mass of X and identify the element. [2]

4. (M04) 100 cm^3 of ethene, C_2H_4, is burned in 400 cm^3 of oxygen, producing carbon dioxide and some liquid water. Some oxygen remains unreacted.

   (a) Write an equation for the complete combustion of ethene. [2]

   (b) Calculate the volume of carbon dioxide produced and the volume of oxygen remaining. [2]

5. (M04)

   (a) Write an equation for the formation of zinc iodide from zinc and iodine. [1]

   (b) 100.0 g of zinc is allowed to react with 100.0 g of iodine producing zinc iodide. Calculate the amount (in moles) of zinc and iodine, and hence determine which reactant is in excess. [3]

   (c) Calculate the mass of zinc iodide that will be produced. [1]

TOTAL = 50 marks

IB CHEMISTRY HL mark scheme topic test 1 2006

SECTION A

1. A 2. D 3. A 4. B 5. B 6. C 7. B 8. A

9. B 10. B 11. D 12. B 13. C 14. D 15. D 16. D

SECTION B

1. (a) $CuO + 2HNO_3 \rightarrow Cu(NO_3)_2 + H_2O$ *[1]*

(b) $0.036\ dm^3 \times 1.15\ mol\,dm^{-3} = 0.0414\ mol$ *[1]*

(c) $\left(0.0414\ mol\ HNO_3 \times \frac{1\ mol\ Cu(NO_3)_2}{2\ mol\ HNO_3} = 0.0207\ mol\ Cu(NO_3)_2\right)$

$\left(0.0345\ mol\ CuO \times \frac{1\ mol\ Cu(NO_3)_2}{1\ mol\ CuO} = 0.0345\ mol\ Cu(NO_3)_2\right)$

HNO_3 is limiting reagent (*Must be justified, not guessed. Allow ECF.*) *[1]*

therefore 0.0207 mol $Cu(NO_3)_2$ formed (*allow ECF*) *[1]* *[2]*

(d) $63.55 + 124.02 + 54.06 = 241.63\ g\,mol^{-1}$ *[1]*

$241.63\ g\,mol^{-1} \times 0.0207\ mol = 5.00\ g$ *(allow ECF from (c) and from molar mass)[1]* *[2]*

2. (a) $4X + 3O_2 \rightarrow 2X_2O_3 / 2X + 1\frac{1}{2}O_2 \rightarrow X_2O_3$ *[1]*

(b) mass of oxygen $= 2.199 - 1.239 = 0.960\ g$;

amount (mol) of oxygen $= \frac{0.960}{16.00} = 0.060$;

amount (mol) of X $= \frac{2}{3} \times 0.060 = 0.040$;

$= 30.97 / 31.0$;

X = P / phosphorus;

[5]

(c)

	N	O
mass in 100 g	25.9	74.1
amount (mol)	$\frac{25.9}{14.01}$	$\frac{74.1}{16.00}$;
mole ratio	= 1.85	= 4.63;

formula N_2O_5;

[3]

3. (a) $3Ag^+(aq) + XO_4^{3-}(aq) \rightarrow Ag_3XO_4(s)$; [2]

[1] for balanced equation and [1] for states.

(b) (i) $n_{Ag+} = cV = 0.2040 \text{ mol dm}^{-3} \times 0.04118 \text{ dm}^3$

$= 0.008401 / 8.401 \times 10^{-3} \text{ mol}$ *(–1 SF)*

Unit not needed for mark. [1]

(ii) $n_{Ag_3XO_4} = \frac{1}{3} n_{Ag+} = \frac{1}{3} \times 0.008401 \text{ mol}$

$= 0.002800 / 2.800 \times 10^{-3} \text{ mol}$ [1]

ECF from (a) / (b) (i).

(iii) 0.002800 mol weighs 1.172 g

$1 \text{ mol weighs } \frac{1.172 \text{ g}}{0.002800 \text{ mol}} = 418.6 \text{ g mol}^{-1}$ [2]

Accept answer in range 418 to 419.
No penalty for too many sig figs.
ECF from (b)(ii) (g mol^{-1});
Do not accept g.

(iv) $(3 \times 107.87) + x + 4(16.0) = 418.6$ *(ECF)*

therefore, $x = 30.99$ *(accept 31.0 / 31)*; [2]

P / phosphorus;

4. (a) $C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$; [2]

Award [1] for formulas and [1] for coefficients.

(b) (CO_2 produced) = 200 (cm^3);

(O_2 remaining) = 100 (cm^3); [2]

ECF from 2(a).

5. (a) $Zn + I_2 \rightarrow ZnI_2$; [1]

Accept equilibrium sign.

(b) (moles of) zinc $\left(= \frac{100.0 \text{ g}}{65.37 \text{ g mol}^{-1}} \right) = 1.530$;

(moles of) iodine $\left(= \frac{100.0 \text{ g}}{253.8 \text{ g mol}^{-1}} \right) = 0.3940$;

ECF throughout.
-1 *(SF) possible.*

(reacting ratio is 1:1, therefore) zinc is in excess; [3]

Must be consistent with calculation above.

(c) (amount of zinc iodide = amount of iodine used $= \frac{100.0}{253.8}$ moles)

(mass of zinc iodide $= \frac{100.0}{253.8} \times (65.37 + 253.8) =$) 125.8 (g); [1]

Use ECF throughout.
-1 *(SF) possible.*